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PERSPECTIVE;

OR THE

ART OF DRAWING WHAT ONE SEES

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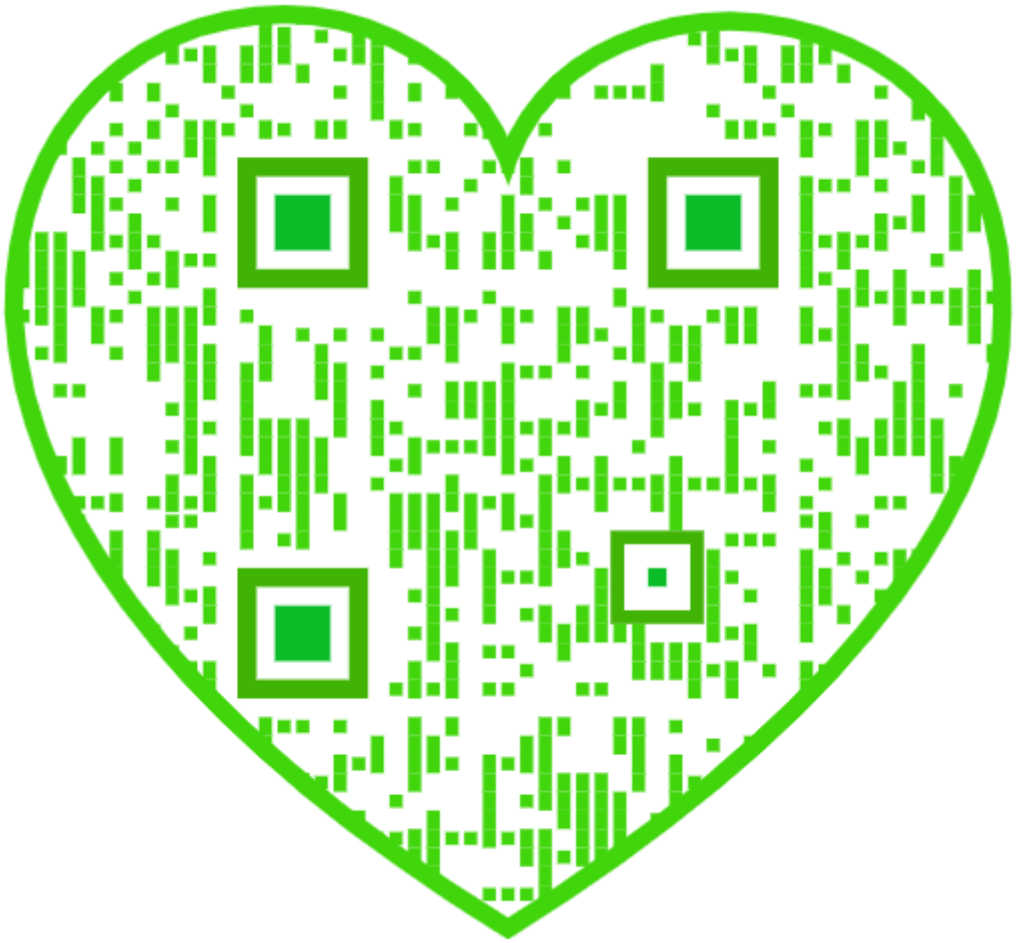

THE ART

OF

DRAWING WHAT ONE SEES.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

SKETCH OF AN INTERIOR.

Note.—This drawing has a contorted and skew appearance. This is due to the distance of the eye, OO being made sufficiently short to fit on the paper. If one eye be placed above O at a distance of 4½ inch (viz. CO) the other being closed, the drawing will assume a natural appearance.

PERSPECTIVE

OR

THE ART OF DRAWING WHAT ONE SEES

EXPLAINED AND ADAPTED

TO THE USE OF THOSE SKETCHING FROM NATURE.

BY

LIEUT. W. H. COLLINS, R.E. F.R.A.S.

Late Instructor in Surveying and Military Drawing in the Royal Military Academy, Woolwich

LONDON:
LONGMANS, GREEN, AND CO.
1872.

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TO

E. N.

I DEDICATE THESE PAGES

IN REMEMBRANCE OF ATTEMPTS MADE TOGETHER

TO SKETCH FROM NATURE.

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PREFACE.

So MANY DRAWINGS, otherwise pleasing and effective, are marred by defects in their 'perspective,' that I need make no apology for attempting to explain, in a simple and concise manner, the few rules which must be followed, either instinctively or with intention, before a drawing can be a true picture of what it is designed to represent.

Knowing that one is naturally frightened from a subject the entrance to which he sees barred by formal treatises full of geometry and 'propositions,' I have endeavoured to write as simply as possible,

and to bring the subject within the comprehension of the most ordinary intelligence. The novice may take heart in knowing that the necessary rules are few, and their application easy.

In the hope that I may have at least partially succeeded in rendering intelligible, if not interesting, a subject generally most unattractive, I offer this volume to those who feel in need of help in their efforts to sketch or colour.

W. H. Collins.

June 1872.

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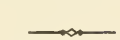
PERSPECTIVE DRAWING.



The writer of the following brief treatise on 'Perspective Drawing' has found through an experience of some length that an amateur, in seeking to provide himself with information concerning drawing from Nature, is at a difficulty in doing so. He stands between two classes of writers—artists and geometricians, neither of which exactly supplies his want. The artist's eye and sense of beauty are pained by anything like a formal 'engineering drawing,' and his treatise gives a wide berth to rigid and exact rules, which here, as in other matters, fence round the processes of Nature. The geometrician is skilled in drawing at his desk. He is satisfied if his figures embody the *proof* of his propositions. He concerns himself more with the proof than with the drawing. It does not matter in the least how ill the schoolboy draws a

circle on his slate; his demonstration is not affected thereby, and the truth of any problem in geometrical perspective is independent of the appearance of the figure. Thus the geometrician is careless of effect, and careful only of his demonstration. He writes for the scholar and his examination paper. It may be that he has never tried to take a sketch from Nature, and does not know how far his theories may be made to furnish rules for his practice.

'Beauty,' 'tone,' and 'feeling' of a picture are the terms which the artist loves to use; and if familiar with the terms and definitions of the geometrician, he is loth to perplex his pupils' minds with them. He probably thinks that the rules for what he calls 'foreshortening' are either inapplicable or too abstruse to be succinctly explained. He is more disposed himself to leave all human habitations with straight walls and parallel lines, and sketch in solitude, among rocks, rivers, and clouds, where he will find his most beautiful effects, than to concern himself with 'vanishing points' and 'points of sight' around some formal building. He may not know that perspective has furnished rules which in most cases can be brought to bear upon his drawing, and by which

he may be tried with no uncertainty, and by which he may be either acquitted or condemned.

The writer of this short treatise thinks that he may supply the want which many of his friends have felt. He has endeavoured to modify and adapt some geometrical constructions so as to make them suitable to the amateur, and he has treated of some general points connected with drawing. He has touched but very slightly on the subject, still vague and indefinite, of colour and composition.

Any drawing in which the lines are ruled has an unpleasing and formal effect. Though the lines may in reality be straight, they look more satisfactory when drawn with the hand than with a ruler. In the former case each stroke the artist makes will carry with it his 'touch'—his 'personal equation,' to borrow a term from mathematics, and will render the drawing essentially his own, and consequently it will carry with it a value far higher than if he had traced it with a ruler on a pane of glass. But even when done with his own unguided hand, the pleasing effect is due to the above cause, not because a discretion has been allowed in the direction of the lines, or that their position has been varied at his pleasure. They must be placed where they appear to be. No

variation is allowable in their position. The general objection to the engineering drawing is not because the lines are wrong, but because (when they represent 'perspective,' which they mostly do not) they are ruled, and because no effect of light and shade is attempted. Dr. Brook Taylor, an eminent authority on this subject, makes the following remark:—'How many pictures are there to be seen that are highly valuable in other respects, and yet are entirely faulty in this point (perspective). Indeed, this fault is so very general that I cannot remember that I ever have seen a picture that has been entirely without it; and, what is the more to be lamented, the greatest masters have been the most guilty of it.' The writer so fully agrees with this remark that he is emboldened in his attempt to handle the subject in a popular way, and make it intelligible to those who dislike geometry and mathematics.

Only two grounds for an opinion can be offered with confidence—the rational satisfaction of the mind that the opinion is just, and a credential in the form of results produced by acting on the opinion. Artists who have treated of this subject have written in the latter sense, and their opinions have carried weight, *per se*, in proportion as their

pictures have been pleasing. The former is the ground of the conclusions offered in these pages. Drawing, light and shade, and colour are the three branches into which the art of painting divides itself. The two last are based upon the first, and however little of the satisfaction afforded by the finished picture is generally ascribed to the drawing, if this is not correct, the other two, however varied, are powerless to remedy the defect which underlies the whole. If, on the other hand, the drawing is correct, the others become optional, and in a great measure please or displease, according to the taste of the observer.

There are a few words which must constantly recur in this treatise, and it is necessary that a distinct idea should attach to each of them. As a description of anything is being given—say, of a piece of machinery, the listener ought to be able to build it in imagination ; for each new line of explanation he will add a new piece to it, and finally his physical conception of the machine will correspond with the existing one. It is desirable that, when planes and lines are talked of, the reader should build such an image in his mind that he would have no difficulty in actually constructing it out of cardboard and lines of thread. Such distinct

conceptions should accompany the terms that will here be described as simply as possible.

A 'line' will be what mathematicians call a 'right' or a 'straight line,' or, in other words, a line that has no bend in it — such a line as is produced by folding down a sheet of paper. The creased edge is a straight line.

'Parallel lines' are those lines which, lying in the same plane, do not meet even if produced. Lines drawn on a wall would be lines in the same plane. And if, like the tiers of bricks, they did not meet or approach each other, they would be parallel. The two metal lines of a railway, when straight, are parallel, for they lie on the same plane, and are always the same distance apart. It is not sufficient that the lines should not meet to make them parallel. They should also be in the same plane. For instance, a road running underneath a railway would never meet the railway; but here they do not run side by side or lie in the same plane, and, consequently, though they would never meet, they are not parallel.

A plane is a perfectly flat surface, with no hollow or bend in it. It must be like the surface of a plate-glass window. A vertical plane is one that hangs like a sheet suspended from a line.

A horizontal plane is one that corresponds with the surface of a vessel filled with water at the same place.

'Perpendicular to' or 'at right angles to' mean the same thing. The candlestick is perpendicular to its base and to the table. In the ordinary position of the table its surface is horizontal, and the stem of the candlestick is vertical; but if the table be tilted up, the candle will still remain perpendicular to the table, though the table ceases to be horizontal, or the candle to stand vertical. A cord hanging with a weight to the end of it is vertical; it ought not to be called perpendicular.

A line is perpendicular to a plane if it meets it directly, and inclines to no side—as the stem of a candlestick meets the base which it stands upon, but this perpendicularity will remain, even though the candlestick be laid upon its side, or held in the hand. It is desirable that this distinction should be borne in mind, for the terms 'perpendicular' and 'vertical' are frequently confounded.

An 'original' line or figure is the actual line or figure which we sketch. Its representation upon the drawing is its 'projection.'

The drawing of a line upon the paper is called 'plotting' the line.

The angle which two rays converging on the eye contain between them is said to be *subtended* at the eye.

The word 'data' is frequently used when any problem is considered. It means all that is given to us, or that we know for certain. Every problem consists in trying to arrive at something that we do not know from what we do. All that we may assume as known is our data.

A 'perspective picture' of an object is an enlargement of the picture thrown on the back of the eye through the pupil, and interpreted by the brain. The perception of the object or interpretation of the little picture within the eye is *sight*; and the image itself, or an enlargement of it, is the 'perspective' view, or that which was or might have been seen or perceived with ordinary undistorted vision.

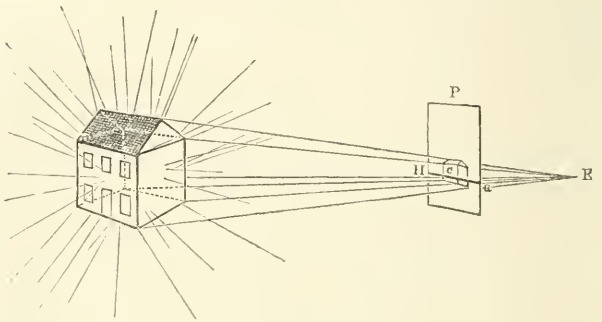
Every object in Nature which is illuminated emits from it rays of light in all directions, in straight lines. That portion of these rays which come from any object to the eye is called a pencil. The eye only becomes conscious of the presence of the object through the effect of these

rays emitted by it impinging on the sensitive nerve within the eye. They must be considered as much realities as telegraphic wires; they must be considered as a multitude of threads running from all points of the object into the eye. Before the existence of these rays was known, people looked upon light as a sudden consciousness of the presence of things in the direction towards which the eye was turned. They looked upon the eye as an opening through which the intelligence had access to the outside world, and by spasmodic inspiration became aware of the objects before it; but this is not so. It is now known that a peculiar impulse is transmitted to the eye in a straight line from every point of an object. Each line of motion along which this impulse travels is called a 'ray,' or, when considered in reference to drawing, a 'projector;' and all drawings formed according to some defined principle by these 'projectors' is called a 'projection.' Any set of rays converging on a point is called a 'pencil.' If any of these rays should happen to enter the eye, the object is seen in the direction from which they come. Those issuing in one direction do not interfere with or obscure those issuing in another. They cross each other in what might appear to be the

wildest confusion, and yet without jostle or disturbance. Each one of twenty persons in a room can see as distinctly as if he were alone, and yet the pencils converging on their eyes may have crossed in every conceivable direction.

Let us consider a square house, this being one of the simplest objects that could be drawn—as emitting rays from it in all directions.

Fig. 1.



And let E be the position of an eye. As is natural to suppose, only those rays which fall into the eye can affect it, and these must of necessity be limited to the pencil converging on it. Other rays striking out in other directions might meet other eyes, but except those lying within the pencil converging on E, none would reach this

point. It is with this pencil perspective drawing is concerned. It is so called from being the natural representation of the object as presented to us by our sight (*perspicio*—I look at). Now, imagine a plane called the 'plane of the picture' held athwart the pencil of rays, and suppose the rays to stamp themselves upon it, as they pass, and we should have a perspective view of the house. E is the point of sight or vertex, P is the plane of the picture. C, where the central ray of the pencil meets the plane of the picture, is the 'centre of the picture.' This point C is called the point of sight by some writers on perspective, but it will here be called by its true name, the centre of the picture. As this point lies on the paper, and is not the point from which the sight is taken, 'point of sight' is obviously a misnomer; E, the central ray, is 'the line of sight.'

The pencil of rays should be cut perpendicularly by the plane of the picture, or in such a way that the cone formed should be what is called a right cone, as in fig. 2, not as in fig. 3.

In this way, standing before a pane of glass and shutting one eye, the distant view may be traced with a pen and is a true perspective drawing, but care should be taken that the view should be *direct*

through the glass, as in fig. 2, not oblique as in fig. 3.

Fig. 2.

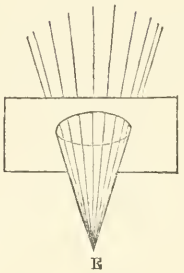
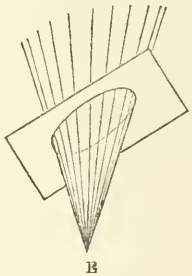


Fig. 3.



This plane of the picture will in the following treatise be supposed to be always vertical and held as here described *direct* across the line of sight. 'Perspective' embraces all positions of this plane, oblique as well as not vertical, but the requirements of painting limit us to the above simple positions, and consequently free us from much complication.

It is not necessary that all drawings should look natural or pleasing. It will be seen (fig. 1) that of the myriad of rays issuing from the house but one small portion has fallen upon the point E. It is quite allowable and frequently desirable that other rays or projectors should be considered, or that they should be conceived to fall in some other manner

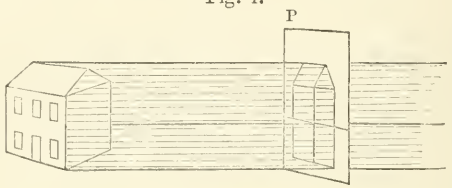
than simply on a point. It would thus appear that there may be many other kinds of drawing besides perspective—and this is so. The architect who designs a house must convey his idea most accurately to the bricklayer and mason who will build it, and for this purpose 'perspective' would not be suited. A general impression of the house might be sufficient for the man who was going to live there, and a perspective drawing representing what he would see if it were built might satisfy him, but such general information would not be of the slightest use to the bricklayer or mason. To meet this end another kind of projection has been devised, called orthographic. It is much simpler than perspective. It could never be seen by the eye.

Rays which issue from the object parallel to one another are to be considered in this kind of drawing. We have now to select a *column* of rays proceeding from the object, and no longer as before a cone of rays. Let the object be a house.

Any set of parallel rays may be chosen according to the view we wish to represent. These rays are again supposed to be cut by a plane held athwart them, and each ray is supposed to stamp its own impress on the plane. We should thus

get a picture, but it would be as big as the house itself. And consequently before it could be shown on paper it would have to be reduced and drawn by scale, say $\frac{1}{50}$th or $\frac{1}{100}$th of its true size. Frequently in a railway station one sees pictures of this kind. They are generally very formal and very straight, no lines converge on them, and all attempts at embellishment or effect are absent. The figure represents such a picture.

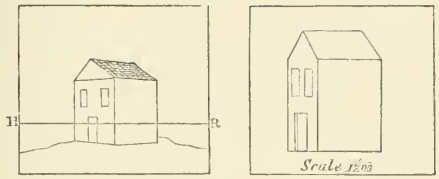
Fig. 4.



It will be well to compare these two kinds of drawings, that their differences may be noticed. It will be seen that in the perspective drawing the size is much reduced, whereas in the orthographic it is the same size as the original. It will also be noticed that no matter where the plane of the picture cuts the rays in the latter case, the projection is the same; while in the perspective drawing it varies greatly with every change either of the position of the eye or of the plane of the picture. Another difference is that in the per-

spective drawing the bounding lines of the house converge, whereas in the other they are parallel The two views are placed side by side.

Fig. 5.

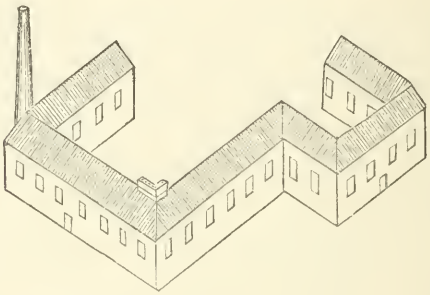


It would be useless to attach a scale to the perspective drawing, for all the lines are not diminished on the same proportion, and it would be impossible to find from it by measurement the length of a line in the house. It will be gathered from this comparison that an orthographic projection is a much more easily made drawing, and much more easily deciphered.

It is frequently thought more desirable to show a great deal in one picture than to represent it either as it might be seen or so as to enable a builder or landscape gardener to undertake the construction of the house or grounds. And for such a case as this another projection has been devised. A different set of rays would be selected

from those chosen in either of the other cases. Those coming from the corner of the house would be dealt with, still keeping parallel to each other. Like orthographic drawing, it would be an imaginary picture, and could be seen nowhere, but, as before explained, the rays issue from all parts of the house, and it is quite allowable to choose whichever direction is convenient for the formation of a picture. That only will appear natural which is given by converging rays, but others may give a

Fig. 6.



great deal more information and consequently may be preferred.

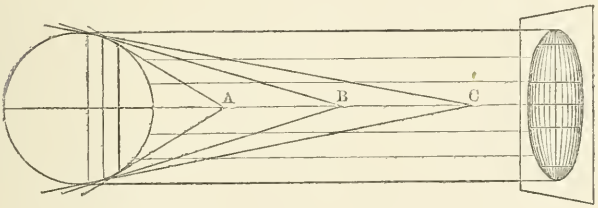
The owner of a manufactory who was anxious to show the extent of the premises would select this kind of drawing.

We frequently see such drawings in railway

stations, in which the outside and a great portion of the premises of a factory are visible. They appear to be standing on a slope, and are something of the nature of a bird's-eye view.

If we wished to take a map of the earth, we should have to resort to some other kind of drawing. As can be imagined, the earth could not be *seen* from any point outside it, being too big. To see one-half of it one would have to go infinitely far away, otherwise, as is evident from the picture, he would not see a hemisphere. At

Fig. 7.



each successive point, A, B, C, &c., he would see more as he receded, but would never, until he was infinitely far away, see the whole hemisphere, supposing his sight to be strong enough. The rays to his eyes would then cease to form a cone. They would be parallel, and the drawing formed by them would be orthographic. But to both of

these kinds of drawing objections would attach. It would be necessary for the perspective view to fix the point of sight, and its position would be completely arbitrary; and in the orthographic picture, as shown in the figure, those portions of the earth near the edges would be much foreshortened and crowded together.

To meet these objections a projection called stereographic has been invented. A photograph of the surface of the earth taken from the inside, supposing the earth to be a shell, would give such a picture. It would have many advantages over the other kinds. The pictures of the hemispheres of the earth seen in the early pages of atlases are of this kind.

This much has been said to show that 'perspective drawing' is one of many kinds; its character, like that of the others, is fixed. Its rules are well defined, so that it is taken out of the region of generalities and ambiguities too generally indulged in by writers on drawing and painting. Of all the kinds of drawing mentioned it is the most difficult. The original purpose of a drawing—viz. to give information concerning the object it represents—has been to a great extent foregone in perspective pictures. Effect and beauty have pushed this

other purpose from the field, and consequently true perspective, though the base and foundation, is but a part of any drawing. It is to be regretted that the rules for pleasing composition and effect have not yet been efficiently explained. There can be little doubt that if the artist could explain his processes, his pupils would find it easier to follow him, than when he represents his power to arrange and please as some peculiar faculty incapable of explanation, and only to be acquired by a life's practice.

It is thought by a beginner that correct drawing is the result only of a correct eye, and that, like the poet's art, the peculiar faculty must be born with one, and cannot be acquired; but it is astonishing how bold one becomes in a fight when well armed, and it is astonishing how soon the novice is capable of bringing rigid rule to bear upon the production of his own drawing, and upon the criticism of his master's. Master and he have then become pupils of Nature, which as a teacher has this advantage, that she never varies. Questions, no matter where asked, will receive the same reply. The same experiment will have the same result, and they who find out the rules of perspective or of colour in England and in China

will find that their explanations, when translated, are the same.

Having had some experience in the instruction of youth, the writer is of opinion that the most frequent cause of failure in attempts both in drawing and colouring is—not knowing how. It is not generally a failure of intelligence or capacity. The bad drawing is to be traced to three defects—not knowing how, indifferent tools, and the absence of muscular skill due to practice. The first two can be overcome by the teacher, if he is master of his subject; the latter can be acquired with the requisite amount of practice. It would then be found that our belief in the 'God-gifted' faculty would be shaken, and, as we are not surprised at a carpenter of dull intelligence making a good box, we shall cease to be surprised at a stupid boy making a fair drawing. Of course it is left to the few to achieve eminence. Broadly speaking, the amount of practice is the measure of the success. The muscles must be schooled to *recollect*. The fingers will play a tune that they know, while no mental efforts direct them. A difficult piece is played by fingers which are already familiar with the thousand small combinations which go to build up the whole. So with a painting, muscular

skill, and the practice of years, lies underneath the oil colours and their pleasing effect.

Fortunately the number of aspirants to honour in the arena of art are increasing, and there is a hope that, when art is in the hands of a greater number of educated men, we shall hear less of canting phraseology and more of the simple and rigid rules, which some good men will glean from nature, by the same inductive process which has been successful in other matters.

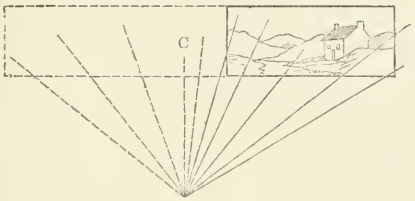
We will now discuss the character of perspective drawing more in detail. Referring to fig. 1, we see the nature of the drawing. The impression received in the eye is nothing more than the image on the plane reduced in size.

It is obvious that the position of the eye may be anywhere, as also the position of the plane of the picture. An alteration in the position of the first would give a new picture, for a new cone of rays would impinge upon the eye; but an alteration of the place, where the plane of the picture cut the cone, provided it be held straight across it (i.e. perpendicularly to central ray), would only cause a difference in size of the picture. Holding a sheet of glass before the eye, and moving it nearer and farther from the eye, would only have the effect of

diminishing or increasing the size of a picture traced upon the glass in either position. The appearance would remain unaltered. As the position of the eye and of the plane of the picture may be anywhere, it follows that before a perspective picture can be drawn, or before the true character of an object can be accurately ascertained from its picture, these positions should be known. It may be remarked that if the plane be held obliquely, just as good a picture would be seen through as it if it were held straight or perpendicular. And yet this position has been forbidden. The reason for that is this, that in looking at any object the centre of the picture seen by us is on the axis of the eye. In other words, the image cast by the lens which lies over the pupil is equally disposed round the axis or central line. In the same way a picture taken by a camera has for its centre the axial line of the camera. If a view seen through glass held obliquely were traced with a pen, and then looked at *directly*, it would appear untrue. It would not be what the perspective view is meant to be—viz. that which might have been perceived or seen. Only a portion of the whole pencil entering the eye would have been projected, and, in order that the picture

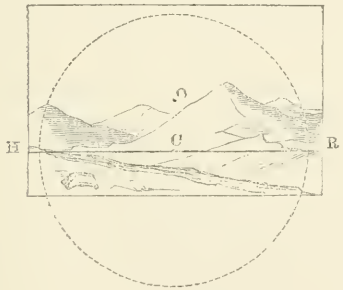
should be a complete one, the plane of the picture should have been extended equally far on the other side of the axis.

Fig. 8.



All the dotted rays should have been allowed to project themselves upon the glass. Another suf-

Fig. 9.



ficient reason would be that in looking at anything one instinctively puts it directly before him, and he directs the axis of the eye on each point. He would stand directly before a picture in criticising it, and would consequently condemn as distorted a

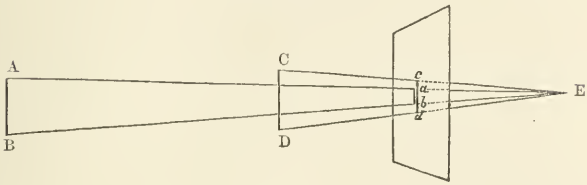
picture taken obliquely as above described. It follows from this that the point of sight should be opposite the centre of the picture. It ought properly to be over the exact centre o, for the eye looking in any one direction receives a circular image equally trustworthy at equal distances, such as is represented by the dotted circle; but the direction of ordinary vision being as a rule horizontal, there is a field of greater interest above the selected centre than below it, and artists generally place what is in reality the centre of the picture about two-thirds down the central line at B. In the photographic picture, before the artist has shaped it to his desire, the centre of the paper is the true optic centre.

One of the differences noticed (fig. 5) between the perspective and the orthographic projection was that the lines of the house in the first converged, whereas in the latter they did not. Now the reason of this will be explained. Let there be two objects of equal height, one more distant than the other, and let the rays from each be traced to the eye through the plane of the picture.

It is seen from the figure that the pencil from the distant post A B is narrower than that from the near one C D, and consequently would stamp the

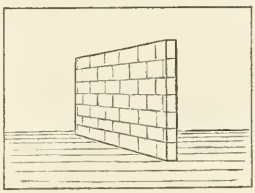
glass with a shorter image than the other. An image appears to us big or little according to the

Fig. 10.



angle under which it is seen. And the distant figure is said, in the language of mathematics, to 'subtend' a lesser angle than the near one, A E B being less than C E D. If the tops of the two posts were connected, they might represent a wall with parallel edges, and the projection of the wall would evidently be as in fig. 11, diminishing in height as it recedes, until finally, if the wall should

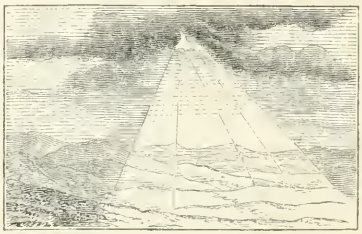
Fig. 11.



be long enough, the two edges would *vanish* in a point. If there should have been tiers of bricks

in the wall, these will follow the same rule, and merge into what is called the vanishing point of their parallel edges. All *parallel* lines have a vanishing point. It was seen in the picture of the house that the lines of the sides approached each other as they receded from the eye; each set of parallel lines was on its way to its vanishing point. Frequently one sees a beam of light falling through a break in the clouds, and it appears to expand like a fan as it approaches the earth. This effect is simply due to the aperture in the clouds, through which the beam comes, being considerably farther from the eye than where the beam falls on the ground. The width of the beam at each end is the same, but, for the reasons explained in the

Fig. 12.



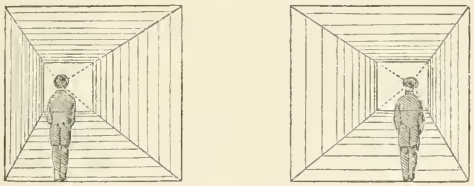
case of the wall, the edges converge towards each other at the end farthest from the eye.

It now becomes necessary to find out where this

vanishing point may be. All persons attempting to sketch from nature will admit that such lines converge, but it is not everyone who can put the point of his pencil on the spot in his drawing into which they should run.

Suppose that one is standing in a square tunnel and looking towards the end. He will see such a view as this (fig. 13). As he changes his position

Fig. 13.



from side to side, he will notice that the point into which the bounding lines of the tunnel run will change also. They, in fact, will always fall into a point where a line from his eye parallel to any one of them will strike the background. Suppose that all of the tunnel but one wall should be removed, and we have the edges of that wall running into a point on the drawing where a line from the eye parallel to the wall would strike the background of the view. It will presently be seen how extremely easy is the application of this principle in

practice. These vanishing points ascertained, the rest of the building, supposing it to be one which we are sketching, is plain sailing.

The plane of the picture has been hitherto always represented as standing up vertically before the eye, whereas in reality the sketching pad is held in the lap. The pad is merely the paper on which we copy the supposed tracing on the window-pane. Each time we look at the view this tracing falls on the eye, and by retaining for a few seconds in one's memory what one has just seen, he can transfer it to paper.

The perspective picture being the projection of the object given by the rays converging on a point, as already explained, it follows that the same view of any object could not be seen from two different points. Each point would have its own special pencil of rays, and the pictures given by the intersections of these pencils with a plane of the picture, would of necessity be different. To do justice, then, to the artist's picture, the critic should pose himself in reference to it, so that the line A B, from his eye to the picture, should fall perpendicularly on the point of sight. He would then be in reference to the picture exactly as the artist was in reference to the view which he painted;

and his distance from the picture should be the true distance of the artist's point of sight from the plane of his picture. If, as we originally supposed, the drawing had been traced on a piece of transparent glass, while the head remained steady and one eye was shut, and was afterwards transferred to paper, and made into a picture, the distance of the observer from the picture should equal that of the eye in the first instance from the glass. To receive in some cases a fair impression from the drawing this becomes necessary, and in others it is immaterial. If, for instance, the view was one of a house, and the artist stood very near it in sketching, it would take such a form as is shown in fig. 14A, the lines of the two sides

Fig. 14A.

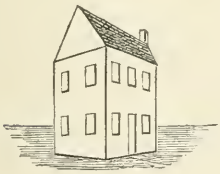


Fig. 14B.

and of the roof converging very rapidly upon their vanishing points, whereas if the house was distant it would appear as in fig. 14B, the same lines converging far less rapidly. A picture of a house as represented in fig. 14A, if looked at from too distant

a position, would appear unreal, while the figure 14B would not appear natural if the critic posed himself too near it. The true position of the observer is that which allows the conditions under which the artist drew the picture to be reproduced as nearly as possible. The eye is so sensitive, and gives the brain such wonderfully exact impressions, which it sometimes takes very delicate and precise reasoning to trace, that it is but just to allow the above restrictions to be observed in viewing a picture. Each point of sight gives a distinct projection of an object, and conversely each projection of a house fixes the point from which it was viewed. The eye becomes so skilled that from the look of an object it will assign almost exactly the position from which it was taken; and if, in looking at a picture, we should do much violence to the feeling of the eye by standing in a wrong position, the picture will appear contorted. For instance, if we view fig. 14A at a considerable distance, it appears a false projection, and justly, for in this case the point of sight is not more than a few inches from the paper. Its exact position is easily ascertained. The view of the interior given in the frontispiece is a reduction of a sketch taken from one end of a

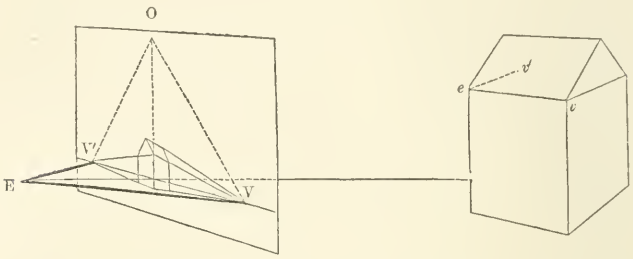
hall. In the case of this sketch the plane of the picture was about ten inches distant from the eye, but in the reduced drawing it is only about five inches—viz. the distance c o. The consequence is that the picture viewed at the distance of ordinary vision—viz. about ten inches—does not appear quite correct. The upper lines in the far wall appear to slope down too abruptly, and the lines in the pavement to slope up too much, but if the eye is held over the drawing at the true distance—namely, c o (supposing this line to stand perpendicularly from the paper)—the hall will assume quite a natural appearance. Indeed, it must needs do so, for the image is that which the real hall produced upon the eye. It is not just, therefore, to view this sketch from a greater distance than c o.

It follows from the description of the vanishing points given above that lines from the eye parallel to the edges of the house—E V and E V′ (fig. 15) parallel to *e v* and *e v′*—will run into the respective vanishing points V and V′, which can be distinctly noted on the background of the picture which we are drawing. When these points are ascertained the lines of the house can easily be adjusted in

their places. The angle at E is obviously the same as that at *e*.

If a drawing should contain the vanishing points of only two lines making a known angle, we can,

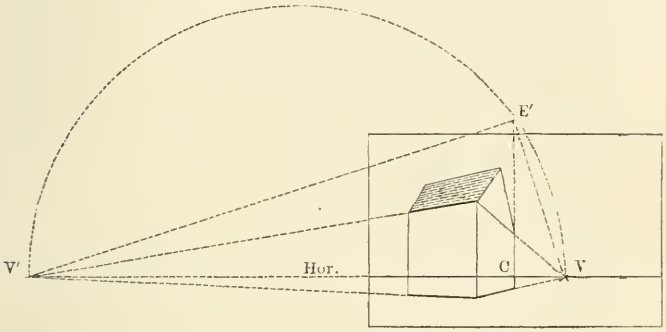
Fig. 15.



by the converse of the above, find the position of the point E or the distance of the eye from the paper. We know that the eye is situated on the perpendicular from the point C. We know also that the two vanishing points subtend the known angle. If we suppose the line C O turned upwards, so as to coincide with the paper, we have merely to find a point E′ on this line such that the angle V′ E′ V is equal to the given one. The angle V′ E′ V (fig. 15) is simply the angle V′ E V turned up so as lie on the paper. Fig. 16 shows such a case, in which the points V and V′ can be found. We know that the sides of the house contain a right

angle. The point E′, found by describing a semicircle on V V′, and marking the intersection with the perpendicular drawn from C gives us the distance of the eye from the picture, viz. E′ C.

Fig. 16.



The describing of the semicircle is merely a contrivance by which (due to the properties of the semicircle) the angle V′ E′ V is insured as a right angle.

Each house, then, that happens to be drawn in a picture fixes the position of the eye of the observer, and if the artist should introduce a second house he is at once liable to error, which may be easily detected, for it is obvious that each house should give the same position for the eye. If they should not do so the drawing will represent an impossibility, and though the observer may

not know why, or be able to interpret the displeasure of his eye, he will probably be displeased with the picture. The behaviour of the parallel furrows or ridges in a ploughed field as we pass rapidly by them in a railway carriage exemplifies very well the character of the vanishing point and its dependence upon our position. The point in the distance into which the lines seem to run travels onward as we advance. Its movement is most striking when we are in a position to look down the ridges (to enfilade them).

It may be thought that such considerations as those referred to here are inapplicable to perspective drawing such as usually undertaken by the amateur, and refer more properly to the drawing of the architect or builder. A straight and formal house would seldom be chosen as the subject of a picture, and the artist may be thought freed from the foregoing restrictions if he should confine himself to waterfalls, mountains, and trees. But all that has been said about the necessities of a house or cube is true of other things. If we change our position in reference to a house its figure changes also. We can in this case determine the distance and the direction of the house from the particular shape it presents on the drawing. In the case of

trees and rocks, their figure changes also for each new position of the eye, but in their case we have not the same power in criticising. Criticism can only come in and approve or condemn where there is some foothold of data to rest upon; but there are very few subjects that can be undertaken of which something definite cannot be predicted. When this is so, criticism can speak confidently. For instance, it is certain that a piece of still water is level, consequently all reflections in it must obey certain laws. The face of a wall is vertical. The roof of a house or cathedral will slope evenly on both sides—the window sills will be horizontal. A variety of such points can be known with certainty in reference to most things looked at. If an artist should draw a picture containing such things, he is at once within the reach of *exact* criticism; not the criticism of feeling, taste, or opinion, but the criticism of law. It might be possible to avoid all such things in the choice of a subject, and evade reproof, and the drawing might escape censure—not because it was right, but because it represents what might have been; the trees may be represented too tall, and the hillside may be drawn steeper than it is, but still what is represented is not impossible.

Books on perspective generally concern themselves with the purely geometrical character of the projection, and the rules and constructions given in them are for the most part inapplicable to the purposes of the sketcher from Nature. Before they can be applied, many lines must be plotted in their original length, or in the case of their being drawn as in the above illustrations, which are purely explanatory, the whole of the data must be plotted in miniature. It is essential in nearly all geometrical constructions that the distance of the eye from the plane of the picture should be known. This distance in the case of sketching from Nature cannot be considered as part of our data. The reader who is familiar with the problems and constructions of the ordinary treatise on perspective will notice that in the following descriptions of how to draw an interior this distance is made to follow from the position of a pair of vanishing points, which are found by the simple methods here explained. In ordinary cases of out-of-door sketching, the distance of the picture is greater than the length of the drawing-pad, and consequently though much assistance may be derived from plotting this line upon the paper, it may not be possible to do so. If the

picture which it is designed to make contains any intricacies of perspective, it is most desirable that this distance should be actually drawn on the paper, as explained in the example given of an interior. If the drawing-pad is not large enough, a piece of paper must be gummed to the margin of the drawing.

The character of the problem which in various forms presents itself to the student of geometrical perspective is this: The distance of the eye from the plane of the picture is given, say two inches; the object to be represented, say a house, stands at a distance of six inches on the other side of the plane of the picture, and is represented in miniature like a toy house. Its position also with reference to the line of sight (see fig. 1), *i.e.*, whether placed straight or sideways, is defined. It is desired to produce the picture of the house formed on the plane of the picture by the converging rays. The *real case* that presents itself is this. Given a real house at an unknown distance, placed in reference to the line of sight in a position not defined, and the plane of the picture at a distance from the eye which, though it may be assumed, is arbitrary (it is usually chosen at a distance of about a foot), it is desired to produce the correct projection. It is seen

that there are few points common to both cases. It follows that the elaborate treatises on the subject may almost leave untouched the points on which the amateur artist might be directed with advantage, or enclose them in so much that is unnecessary that they cannot be easily reached. A few very simple rules will be here laid down and explained. When the reader is sufficiently familiar with them to apply them to the testing of the accuracy of other drawings, he will be surprised to find how few pictures are correct. He will seldom find the picture of an interior of a hall or cathedral but which will represent what did not exist. The typical case above referred to of the miniature house, represented in fig. 1, has of course its converse, viz., given the picture of the house, its distance and the distance of the plane of the picture, to produce the real object in correct proportion. This is quite possible, and is no more difficult than to draw the picture when given the house, but it will be observed that the converse of the proposition in the second case is by no means so easy, and is frequently impossible. It is this: given the picture of an object, such as a picture in the 'Illustrated London News,' to find out the true shape of the objects represented. Our

criticism may not be able to reach this point, but it may be able to pronounce if the picture represents possibilities, or what we know from other considerations must have been; for instance, does it represent the picture frames as rectangles or as diamonds? Are the tiles laid symmetrically? are the columns round? Is the floor horizontal, or is it tilted up like the platform of a stage? These things can generally be decided, and it requires no argument to prove that it is desirable in making a picture of what is before one, to make it to represent what one really sees.

From among the many rules and expositions of perspective, a few may be gleaned which will give material help to the amateur artist, and some may be modified so as to afford great confidence in the execution of a drawing from Nature. It would be quite possible to choose a subject for a picture which, as far as its perspective was concerned, would baffle the criticism of the most exact, and it is fortunate that some of the most picturesque subjects approximate to this character. The more dilapidated the ruin, the more charming is frequently the effect; and the more rugged and amorphous are the fragments of rock, the prettier is the foreground. Still the wall is pro-

bably vertical, the water is certainly horizontal, and if it reflects an image it must do so according to a certain law. An amateur who was obliged to seek such a subject that his picture might evade criticism would be in a sorry condition to undertake a sketch, and his confidence in its execution would be but slight. He would be unable to attempt many of the most interesting subjects. The interior or exterior of his own house would be beyond his power. Sketches of places where he lived, perhaps the most pleasing reminiscences he could lay by, would be too difficult, or, if undertaken, could only be exhibited with diffidence. He has drawn a line for himself which he may not pass, and excellence is beyond his reach.

The apparent size of an object depends upon the angle under which it is seen. Things appear larger when looked at through a telescope simply because the angle under which they are seen is increased. The angle which an object subtends at the eye becomes smaller and smaller as the object is removed, and exactly in the same proportion as its distance is increased. A lamp-post twice as far off as another would subtend half the angle, and, if in the same direction, would be represented in a perspective picture by a line exactly

half as long. This is the key note to perspective, and from this follows the rule the adherence to which is a first necessity of a drawing, viz. :—

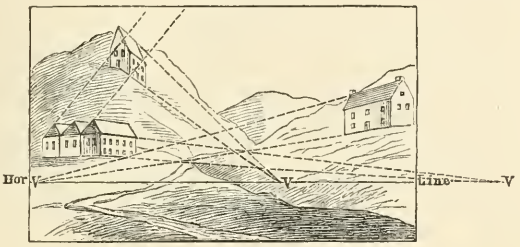
The projections of all parallel lines converge to a point called the vanishing point of those lines.

The lines of a railway, when not curved, would appear to meet each other at some distant point, which is the vanishing point for those lines. The chief difficulty one has in sketching from Nature is to find out where the vanishing points for sets of parallel lines may be. Having found them, the drawing will almost fall into its place. When we come to describe the actual process of taking a sketch, the way in which these vanishing points may be found will be explained. Having found them, we shall be concerned with the question of foreshortening. Pictures and windows oblique to our line of sight must of course appear narrower than they really are, but the amount of this narrowing or foreshortening is not so easily ascertained. We will consider the vanishing point. It may be thought strange that a picture could be made of a line which was infinitely long, and yet such is the base. The vanishing point of a line is nothing more than that point on our drawing where the picture of projection of the line would

end, supposing it in reality to be infinitely long. The line joining the chimney of a house and a fixed star is practically infinitely long, and yet such a line could be projected on the paper of a sketch, and might not be more than a few inches in length. If we suppose the star twice so far as it is, this projection is not sensibly altered. The line has a fixed termination in our drawing, and the point where it terminates is its vanishing point. The question is where is this point? To find it we must let the eye run along the line; the point where the line of sight strikes it becoming more and more remote, the eye can only reach the end when its line of sight is parallel to the original line. The rule then takes this practical form. *Look parallel to any line, and where the line of sight strikes the distant background, there is the vanishing point.* Although most parallel lines which come under our notice are horizontal (*i.e.* level) and consequently will have their vanishing on a line level with the eye, as in the views already given of houses, parallel lines which do not happen to be horizontal, will also have their vanishing point, thus the banisters of stairs, the edges of roofs, beams of light from a cloud, &c., will have vanishing points at different places on the

picture. Such cases are not common except in sketches of interiors of buildings.

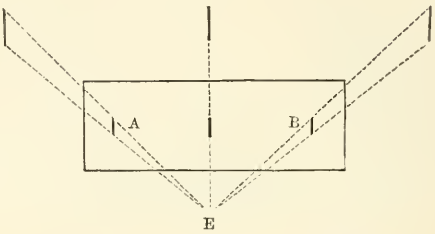
Fig. 17.



We said that a lamp-post if twice as far off as another would be represented by a line half as long, *if in the same direction.* This point must be attended to. The second lamp-post will appear half the size of the others, no matter where it is situated, if it should be twice as far; but we must recollect that we are now concerned with the plane of our picture, and this will cut the two pencils at different distances from the eye. The distances of objects must be referred not to the eye but to the plane of our picture. Thus boys standing, one in the centre and one at each corner of the picture, though the latter are much more distant than the former in reality, must be represented the same height. We will take the case of

three posts of equal height. Although the posts at the margin of the picture are nearly twice as far

Fig. 18.

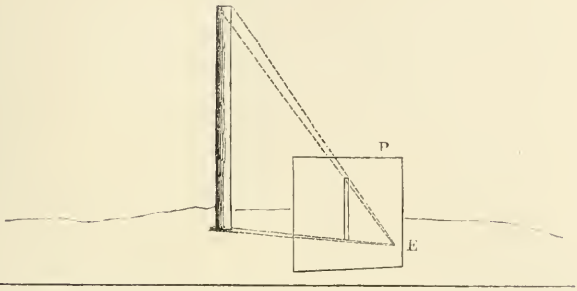


off, and would if in the same direct line as the centre one be represented as *half* the size, they must be drawn the same height as the near one, for it will be seen that the plane of the picture at the points A and B is proportionately farther from the eye, and cuts the pencil further off. This section of the pencil is, in fact, of exactly the same height as the section of the central one.

In the same way, if a column of the same width the whole way up were to be sketched, though the top might be much further off than the bottom, it would be represented as of the same width. The rays from the top would cut through the imaginary plate of glass at exactly the same distance apart at both ends of the columns. Fig. 19 explains such

a case. See also the remarks concerning a pavement, p. 65.

Fig. 19.



It is frequently thought curious, and instanced as a proof of good drawing, that the eye of a portrait should appear to follow an observer through the room. There is no test of good drawing in this fact. If the eye should happen to look at one in any position in a room it should do so in all. When an ordinary eye in life is looked at, the direction of the axis of the eye is determined with

Fig. 20A.

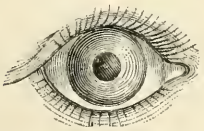


Fig. 20B.

marvellous certainty. We are assisted to its determination by our two eyes, and the combination

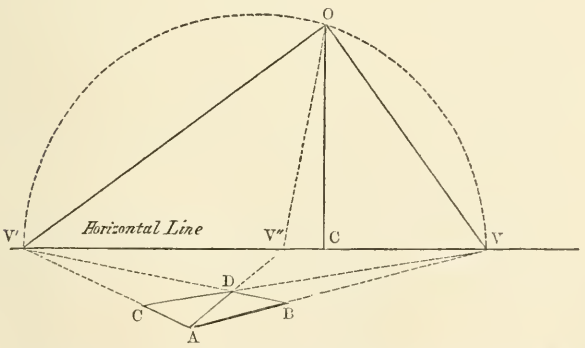
of the two images, and also by the circular or elliptical form of the iris and pupil. If these should appear perfectly circular, as in fig. 20A, the eye confronts one. If, on the other hand, they should be elliptical, as in fig. 20B, the axis of the eye passes to one side of the observer. One knows in a moment if an eye looks at him, and he can tell with almost equal certainty at what object it is directed, or, in other words, we can assign its true position to the axis of an eye from the projection of a circle on it. Now in the portrait this position is fixed by the artist, and to the eye of every observer it is the same; consequently, the impression of direction should be the same to one person as to another. It will be noticed that it is only the eyes of full-face portraits which look at one, unless the head and eyes should have different directions, the latter being as in fig. 20A.

Perspective, as far as pictorial art is concerned, consists of two problems—to produce the projection of an object the character of which is known; thus it may be required to draw a square flag in a pavement, or rectangular picture frame, or to represent correctly the top of a round table. It is of such particulars that a drawing is made up. The other is the converse of this, and affords

us the power of criticising. Given the picture of an object to produce its true character. If the shape which we find the object to be, corresponds with what from other considerations we know it must be, the drawing will pass as correct; if not, it stands condemned as incorrect. Dealt with in geometrical fashion, the first problem is performed in this way.

Let it be required to draw the picture of a square flag in a pavement, one line in the picture being given. Let the given line be A B; the distance of the eye from the place of the picture must be known.

Fig. 21.



Produce A B till it meets the horizontal line in v, its vanishing point. Draw C O perpendicular to v' v, and equal to distance of the eye. Draw O v

and O V′ perpendicular to O V, V′ is the vanishing point of the sides of the square adjacent to A B. Draw V′ B, V′ A. Bisect the angle V O V′ in O V″ and draw V″ A. The point of intersection D is the far corner of the square. Draw D V. The projection of the square is complete. For the clear understanding of the construction, reference should be made to fig. 15, p. 32; the triangle V O V′ in the last figure is nothing more than the triangle V E V′ in fig. 15, turned upwards so as to correspond with the plane of the paper. The angle at E, fig. 15, is the same as that at O, and in the last construction, having got one vanishing point V, the angle at O is made to equal the angle at A (viz. right angle), and the second vanishing point V′ is found. The vanishing point of the diagonal is found by drawing a line from O bisecting this right angle. It will meet the horizontal line in the vanishing point of the diagonal, V″.

The converse proposition is this. Given a figure supposed to represent a square, does it do so? Let it be A B C D (fig. 21), and let the distance of the eye from the paper be equal to O C, turned up as in fig. 15, so as to lie on the paper.

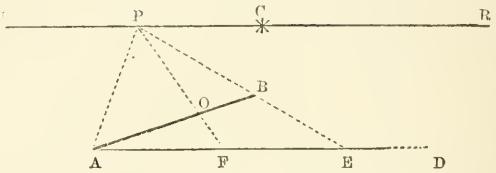
Find the vanishing points V and V′ by producing the sides of the figure. On V V′ describe a semi-

circle. If the point where the line O C is intersected correspond with O, the figure is correct, if not it is incorrect. The points V and V′ being found, and it being known that they subtend a right angle at the eye, the semicircle swept on the line V V′ at once gives us the point O, determining the distance of the eye. Should it correspond with the given distance, the drawing is correct. A very simple case has been taken in the preceding demonstration to illustrate the problem of geometrical perspective. In both it will be noticed that the distance of the eye was given; but assuming the figure in the last to be correct, the distance was found. In most pictures this distance can be found and the remainder of the drawing tested on the assumption that it is correct. The following construction is frequently necessary to the correct disposing of lines and figures in a picture: It is desired to cut the line A B in half—supposed to be horizontal. The portions of the picture of the line will not be equal. Let it be necessary to find the centre of a line which we have chosen to represent the edge of a table or a wall.

Let H R be the horizontal line, and let A B be the line which we wish to bisect. For instance, this

line A B might have been assumed as the length of a table or mantelpiece of which we required the centre. Take any point P at random on the line H R immediately above A B. From A draw a line

Fig. 22.



A D parallel to H R, or to the bottom of the paper. Draw P B, and produce it until it cuts A D in E; bisect A E in F, and join P F; where this line cuts A B—viz. O, is the centre.

If it were required to add a piece on to a line of equal length to itself, this construction shows us how it can be done. Let it be desired to produce A O until the produced part be equal to it. We have merely to draw P O and produce it to F, then to make F E equal to A F and join E P; the point B thus found is the extremity of the line. This is the most important problem. The reader should familiarise himself with it by practice. It is useful in almost every stage in a perspective drawing. It affords us

the power of posing correctly the windows in the side of any building, or panels in a wainscoting, or generally of dividing any horizontal line into equal or assigned divisions.

We will now describe the actual procedure in taking a sketch of an interior. A person who has had much practice in sketching may be able to draw objects very fairly near their true places. But it is simply impossible that they can be really correctly drawn without the assistance which may be derived from such problems as the foregoing. Our sketch will be so chosen as to involve a good deal of 'Perspective.' We will suppose it to be the interior of a hall, hung with pictures and banners, and with a tesselated pavement. (See Frontispiece.) The process will be illustrative of cases that may occur in less complication in any ordinary sketch.

The first thing that will be done is to look round the hall. At once we have an enormous contrast between what we would wish to do and what is possible. Our object is to make on paper such a representation of the hall as shall convey to the person looking at it the same idea that we have received upon our minds from our glancing round it. Our first feeling, knowing how restricted is

our power, is a misgiving lest we should attempt the impossible.

We will just compare these two acts of looking round the room, and looking at our picture when finished. Looking at the hall, we move our head about, and turn it from side to side. We thus gain an idea of the distance of all things in it. Our two eyes also, giving each a different picture, as will be understood when we remember that a distinct pencil of rays falls into each, will lead our brain by its power of combining these pictures to a just estimate of the various positions of objects. The shutting of each eye alternately, while the head remains steady, will prove by demonstration that two distinct visions are seen for each steady glance of the eyes; but, apart from this, the motion of the head is sufficient to produce a distinct idea of distance. This will require some slight illustration. Let one eye be shut, and a finger held before the face; let the head now be moved to and fro sideways, slowly, and let the displacement of the finger over the background of the view be noticed. It will appear to change its position many inches. Now look at some object a few feet beyond the finger, and mark how far it travels over the background while the head moves—probably

not more than an inch or two. Note successively the displacement of objects, more and more distant, over the field of the background, and it will be seen that the change in place of near objects is very great, while that of distant objects is very slight. It is this comparative motion which gives the brain the true idea of distance, and in a slight change of position of the head the artist has satisfied himself, perhaps unconsciously, of how the various objects are situated. The above is in its simplicity the theory of 'Parallax,' by which the distance of the moon—which from the earth is slight,—and the distance of the stars—which is so great that the whole size of the earth and its orbit are but as a grain of sand in comparison—have been ascertained. It appears, then, that there is nothing abstruse in the idea; and when the word parallax is interpreted, it merely means 'comparative change.' Travelling in a railway carriage, we notice that we cannot look at the sleepers on the line, or at the hedge beside us—they move so rapidly. A tree some distance off moves slowly back along the horizon, and a distant object seems hardly to move at all. If we said to ourselves, 'That tree which moves only half as fast backwards as this one, is twice as far,' we should

have done in a small way what the astronomer has done with the stars. It is evident that shutting alternately each eye is the same in effect as moving one open eye backwards and forwards. Each eye in the first case, and each position in the second, will have a new view, and all objects will have made a comparative change of position relative to the background, which has given so great an amount of information that we ought hardly to be surprised if the best picture should be a failure.

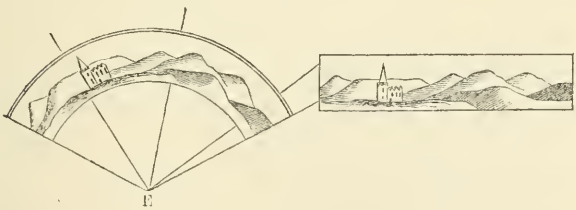
We now come back to our sketch. The artist takes his picture as if he had but one eye; and, as we are now prepared to hear, one eye, if fixed, can have no idea of distance, except what it draws from its previous experience. This can be easily tested by experiment. Try to put the finger of one hand on the point of the pencil held in the other, looking only with one eye, and keeping the head steady. It must be rapidly done to be fairly tried. It is as likely as not that the finger will miss the point. We know from our definition of the picture that it is the projection of the objects formed by a pencil of rays. At once there is an enormous difficulty thrown on the artist. He is to represent in one sketch what he hopes will produce the same idea as a view with both eyes

and a moving head, and, what is of equal importance, with a head which, though it keeps its place, *turns round.* From the definition of our picture, by which we are bound and from which we cannot extricate ourselves, we have *one point of sight*; and we have *one central line of sight*, round which the picture should be equally posed, though it may be, and generally is, extended twice as far above as below for reasons given on page 24. Our picture is taken as if we never raised our eye from where our central line strikes the distant sky, or hills, or bookcase, as the case may be. And yet in sketching we must of necessity look round. In taking a true perspective picture, we are sketching what, properly speaking, we should not look at. The imperfection of our eye in not seeing objects clearly more than a few degrees to either side of the central line, obliges us to look directly at them; otherwise the outline is indistinct and blurred. If this were not so, one might read a whole page of a book without moving his eye from some word in the centre. A mere trial of how far from a word looked at one is able to distinguish other words, will prove how very small a field of view is in focus at once in the eye. Supposing the objects not looked at to be distinct, it is their

projection in this position of the eye that we desire to produce. The back of the eye is slightly concave or hollow, like the palm of the hand, and consequently is not altogether similar to the plate in a photographic camera. The objects only directly in front, or on the axis of the eye, are in true focus, while with the camera plate it is so arranged that a considerable field of view is in focus at once. Our drawing must of necessity be upon a plane surface, and resembles in every particular a photographic picture. In such a picture the objects to either side of the centre are larger than when looked at directly. This will be obvious on reference to fig. 18, p. 44, and from this follows what many persons must have noticed, viz. the difficulty of attaching photographs together so as to form a panoramic view. It is almost impossible to adjust the edges of the pictures, for they are found not to coincide. They would only fit together when at equal angular distances from the axis of the lens, or centres of the pictures. The concavity of the back of the eye and the indistinct character of all objects not directly looked at tend to annul and render unnoticeable the enlargement of objects to one side of the axis, but where the image is received upon a plane

such enlargement is unquestionable. This matter has been dwelt upon, as it is most desirable to have a clear notion of what we see when looking round at objects in reality and when looking at their picture. In the first instance all the objects seen in one sweep of the eye form a panorama projected on the concave surface of a sphere or cylinder if the angle subtended by its width be small, whereas in the other it is the projection on a plane. It would be impossible to adopt a style of drawing truly representing the first condition; we should have to paint our picture on the interior of a bowl, or hemisphere, and the view only could be seen

Fig. 23.



from one point of view at which each observer would have to place his eye. The figure will represent the two cases.

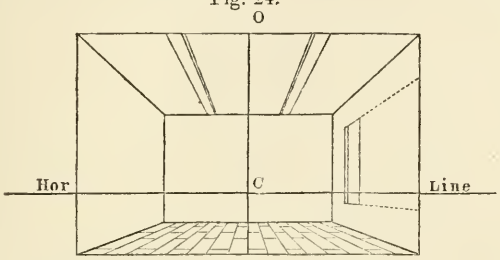
To return again to our drawing, the first thing, after having looked round us, is to choose the

centre of our picture. This should be on an imaginary line drawn across the view at the height of the eye. We are supposed to look straight before us, our line of sight being level, or horizontal. The choice of this centre altogether rests with ourselves. We are going to reproduce on a large scale one of the myriad projections which fell on our eye as we turned the head, and we may take which pleases us most.

A more agreeable and less formal picture is given by taking our line of sight oblique to some of the main original lines. If we prefer to take a direct picture, so that the main lines of the original shall be perpendicular to the plane of our picture, our work will be simplified, but the drawing will be stiff and less pleasing, and the following must be borne in mind: The vanishing point of all such lines perpendicular to the plane of the picture is in the centre of the picture. Adopting the rule previously given, it would be found to be so, and lines parallel to the plane of our picture would have no vanishing point at all, as would also be determined by turning the head and looking parallel to them. The line of sight in this case would not meet the plane of the picture. The drawing would present this effect.

We will choose the centre of the picture to one side of this vanishing point, or, in other words, our

Fig. 24.



line of sight will be oblique to the main lines shown in this sketch.

Having selected a centre of the picture o, a line must be drawn through it as before. It will be about two-thirds down the paper, and parallel with the bottom margin. A line co must be drawn through the centre of the horizontal line—at right angles to it, or parallel to the side edge of the paper. We must recollect distinctly what point in the background is our centre, for it will coincide with the intersection of these two lines. In our sketch it is a point on the pillar seen through the arch. The next step is to hazard the length of some prominent original line near this centre. Having assumed such a dimension, everything connected with our picture is fixed; nothing is now arbitrary. We have, in doing this, assigned

the distance of the eye from the imaginary pane of glass, the image on which we are supposed to be copying. Now, every other line in the drawing must bear its true proportion to this line. Let this first line be the height of the arch; then, on looking at the arch and reflecting, we say, 'Its width is not nearly so much.' We must hazard a width and draw a rough arch. We must now *compare* the proportions of our arch with those of the original. If we are satisfied that they are correct, the drawing is half done, for on this foundation we will build the greater part of it. Our means of estimation and guidance, from this out, for the position of things will be imaginary lines drawn horizontally and vertically. The eye can be trusted to run such lines from any point, and it is by seeing if they cut above or below or beside other points that we estimate the relative positions. Some of the prominent objects near the arch must now be filled in—for instance, the boundaries of the wall facing us. The width and height of the arch will lead us to the fixing the positions for these boundary lines. The wall facing us has simply been sketched in by the unassisted judgment. No detail must be attempted until the framework in which it is to lie has been satisfactorily drawn.

Now comes what is the kernel of our difficulty, and what is a bugbear to beginners—our vanishing points. What lines require them, and where are they? Without them we shall not know in what direction to draw the main lines of the picture, and with them all will be plain sailing. Every set of parallel lines will have a vanishing point. Fortunately we need not be perplexed with many, for the greater portion of our lines, and those the most important, are in one direction. These are the main lines of the hall to our sides, the edges of floor and ceiling to our right and left, the principal divisions in the pavement, the upper and lower edges of the picture-frames, the edges of the hearthstone and mantelpiece—all of which will run to one common point. We find where it is by the rule previously given,—by looking parallel to any one of them, and noting where the line of sight strikes the background. In our picture (see plate), it lies in the pillar supporting the right-hand vase. As all the lines we now are considering are horizontal, the line from our eye parallel to them must be horizontal also. It will impinge upon some point in the horizontal line previously drawn through the picture. It is well to note that while it remained optional with us to select

any point on the horizontal line as the centre of our picture, the vanishing points of all lines are fixed and remain so, however we may vary the plane of our picture, provided we keep our heads steady. There ought to be no difficulty in looking parallel to any line, but we may be assisted in doing so by recollecting that the ray from our eye is to be chosen so that the point where it strikes the background is to be at the same distance from any of the lines as our eye is. In our picture the vanishing point is the same height from the floor as our eye, and also the same distance from the side wall as our eye is. If a division in the pavement should run under our seat, we may be assisted by following it down the hall to where, if produced, it would cut our horizontal line. Let the vanishing point be marked with a cross or star, so that there may be no mistaking it. Into it all the lines referred to must be made to run. It is seen that the drawing at once takes form, and there is a satisfaction in knowing that the framework so far is correct. The vertical edges of the wall confronting us have been already drawn, having been placed where the eye assigned them their position in relation to the arch. It now becomes necessary to fix the upper and lower edges of the wall, and for this purpose,

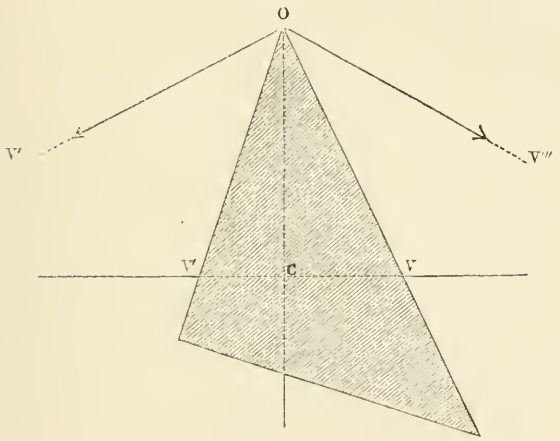
since we have chosen an oblique view, we will require the vanishing point for them, and all lines parallel to them. If we acted upon our rule, and looked parallel to them, or along one of the transverse markings in the pavement, which would be a safe guide, we should no doubt find the vanishing point, but it is obvious that it would not be on the drawing pad. It would cut the plane of the picture at a considerable distance to the left. Our determination of it by this process would be too uncertain. In the former case the vanishing point lay on our paper, and its position was easily laid down among the articles to which we had assigned positions, but here it lies on a part of the background not in our picture. For the present the upper and lower lines of the wall facing us must be assumed, care being taken to make the top line slope downwards considerably to the left. They will presently be corrected to their true places. It was said that in assuming a distance for the height of the arch we fixed the distance of our eye. This is obvious when we consider that the pencil of rays reaching our eye may be cut at any point by the plane of our picture, but that at each point its width and height will be different. If we had traced a house upon a window-pane, we should

find, on seeking to ascertain our point of sight, that our tracing would only fit over the house when we placed our eye at a distance from the tracing which its size had fixed. It would be too big if our eye were too near, and too small if our eye were too far.

The distance of our eye, then, as we have said, is fixed, and it becomes necessary to find what it is. We must look upon the pavement at our feet, and pick out a diagonal line in it. This line lies exactly between the two lines whose vanishing points we have been considering, one of which we have found, and the other of which we could not find. There are certain to be such lines among the tiles; if there were not, we should have to imagine one, and follow it with our sight until we found its vanishing point. In our sketch this vanishing point lies in the fireplace. It lies on the horizontal line as does the other, and for the same reasons. These two points subtend at the eye an angle of 45°. There can be no doubt about this, for rays from our eyes run to them exactly above two lines in the pavement, which are known to enclose 45°, inasmuch as the diagonal halves the angle of the square which is 90°. Our eye is also exactly before the point C, the centre of the

picture. Imagine threads from these two points running into the eye. Now comes a construction which must be carefully attended to. A piece of paper containing a square angle must be folded over so as to halve the angle, thereby producing an angle of 45°, for the whole angle was 90°. This piece of paper must be slid along the

Fig. 25.



line c o, as shown in the sketch, so as to rest with its point o on this line, and a side touching each point v and v'. Mark the point o thus found. This triangle v o v' is the triangle formed by the lines of thread to our eye turned over so as to lie flat upon the paper (see fig. 13). By its aid

we have discovered that the distance of our eye is o c. We can now find any vanishing points with certainty, provided we know what angles they subtend at the eye. v and its fellow v″ that we were looking for subtend 90°. Draw o v″,—which can best be done by opening out the paper—and produce it. This line will intersect the horizontal line in v″. Unless we desire to be very exact, we need not draw more than a short portion of this line (see sketch). Any lines occurring between o v″ and the horizontal line will slope downwards, taking an intermediate position. If this point v″ is even roughly determined, we are in a position to fill in the upper and lower boundary lines of the wall facing us.

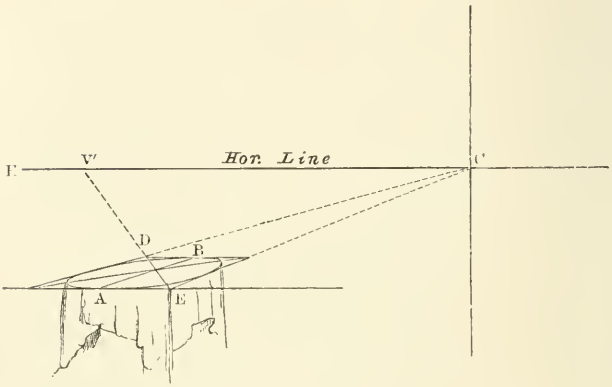
We will now do a little of the pavement. If there is any uniform pattern spread over it, we must divide the bottom margin of our picture into equal spaces, representing, we will suppose, the width of the ladders in the pavement confining the pattern. The width must be hazarded. The number must be counted between two objects already fixed, if the eye cannot assign an approximate value without this aid. What is now insisted on is the *equality* of the divisions (see pages 44 and 45). It is a case similar to that of

the three posts represented in fig. 18. The spaces into which this line is divided do not appear under equal angles when looked at successively, but the pencils from them cut the plane of the picture in points proportionately distant, and consequently the projections, or pictures, of these equal divisions will be equal. Each point given by the division must be joined to v (see frontispiece). If the pattern on the pavement should be squares, the simplest way of getting them in will be by joining these points to v″ also, which point must be found. If its distance should be considerable, a pin may be placed through a loop on a piece of thread and fixed at v″; a line can then be stretched successively to these points. It will be more convenient to find the vanishing point v‴ of the other diagonals, especially if the pattern be diamonds or variegated. (We have already found v′, situated in the fireplace, the vanishing point for the diagonals sloping to the left.) This is effected by making the angle v′ o v‴ equal to 90°. This can easily be done by adjusting the square angle of the paper on the line v′ o and drawing o v‴. The two vanishing points of the diagonals will enable us, without any difficulty, to run up one of the ladders on the pavement, drawing lines

alternately to v′ and v‴. Any variety of pattern can be drawn, as shown in the sketch, with a little ingenuity.

The top of the table is arrived at in this way (fig. 26). Assume A B as its length. Through A and B draw lines to the distant vanishing point v″. Find the centre of the table as explained

Fig. 26.



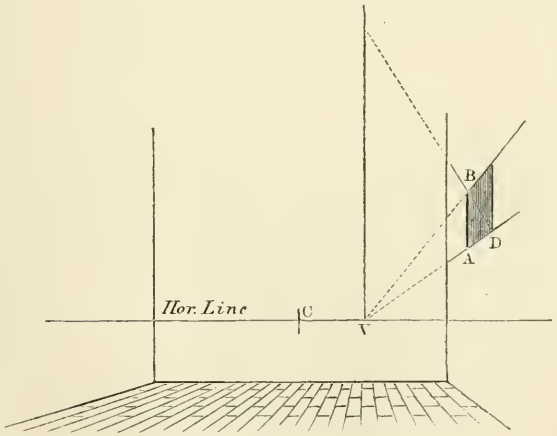
on p. 50. Join the centre so found to v′, the vanishing point of the diagonal, and produce to E. The two corners D and E are thus found. Draw lines through these corners D and E to C, and the sides of a square table are determined. If the

table should be circular, the curved top must be neatly fitted within this quadrilateral.

If the table should stand in the centre of the hall, a vertical line through its centre should pass through the centre of the floor.

The pictures on the wall will be within the guides given by the vanishing point v. The amount of foreshortening had best be estimated by the eye. As there is rarely any definite proportion between the length and breadth of a

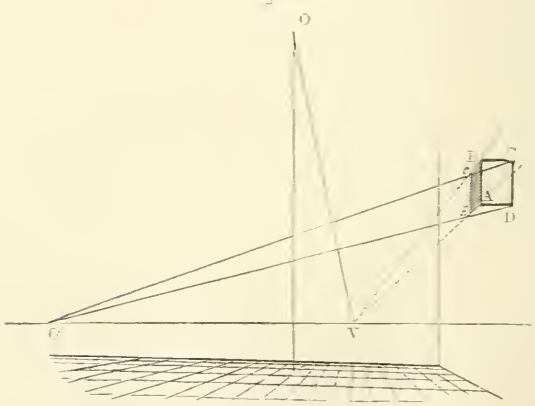
Fig. 27.



picture-frame, this can be done without any violation of a possibility. If the true character of

a frame be known, its *true* projection can be drawn by the process described for laying down the figure of a square—viz. by looking up to the ceiling for the vanishing point V′ (fig. 27), of one of the diagonals, and joining this point to B, the corner of the picture, and producing this line to where it cuts V A in the point D, which is thus found to be one of the near corners of the frame. The vanishing point V′ will lie vertically over V. The point D having been found, the frame is easily completed. The distance of point V′ may render this process impracticable, in which case the

Fig. 28.

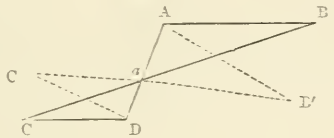


following may be adopted: On the side of the picture A B, the length of which has been assumed,

draw the frame in its true proportions. A B C D. Draw V O′ equal to V O, and join O′ to the far corners of the frame C and D; where the lines so drawn cut the lines VA and VB—viz. D and C—are the far corners of the picture. This construction is more difficult to understand. The principle upon which it is based is this,—the amateur need not trouble himself with it.

If two lines AB and CD parallel to each other be drawn from the extremities of a line AD, and the

Fig. 29.



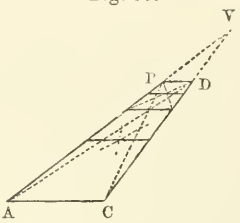
points C and B be joined, cutting AD in *a*, then if AB and CD be turned round to any new positions AB′ and DC′, still retaining their parallelism, the line joining C′ and B′ will cut AD in the same point *a*. (This is evident to the geometrician.) Each new pair of triangles lies in one plane; they are equiangular, and retain the original sides AB and CD. AD will be constantly cut in the proportion, AB : CD, *i.e.* in the point *a*.

The ray from the eye to V (fig. 28) is parallel to the upper edge of the picture-frame, for V is its

vanishing point. The line V B on the plane of the picture connects the extremities of these two parallel lines; the visual ray from the eye to the corner C of the frame joins the extremities of these two parallel lines, and cuts the line V B in *c*. V O′ and C A, still retaining their parallelism, are laid flat upon the paper, and the point of intersection of V B is found at C—the point required. The case is exactly similar to that given in fig. 29. The bisection of the line is based on the same principle.

It is frequently desirable to find out the lines on a pavement which will represent the gradual

Fig. 30.



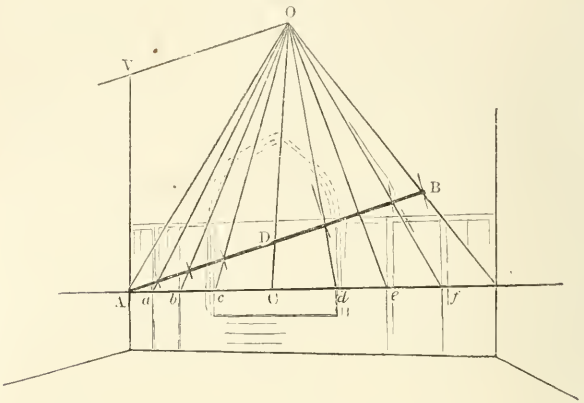
crowding of equidistant lines as they are more and more distant from the eye. Let two parallel lines A B and C D be drawn to their vanishing point V, let the diagonals to the figure be drawn, and let A C and B D be drawn to their vanishing point, thus completing the parallelogram. The inter-

section of these diagonals will mark the point which is equidistant; a line drawn through it to the distant vanishing point will mark off little parallelograms, and the same method of finding their centres can be continued; but in this case it cannot be said whether they are squares or not.

The only point which remains to be noticed in our picture of an interior is the mode of dividing any main line on the wall facing us into the divisions which we see upon it. We have chosen the centre of our picture C, and the position of the arch. We have roughly posed the vertical lines bounding the wall. The distances of these lines from either side of the arch are equal; the divisions in the panelling are also equal. How are the pictures of these points to be ascertained? This problem is generally explained (p. 50, fig. 22), and was made use of in finding the centre of the table. The particular case will now be dealt with. The construction is different from that previously given, as being, perhaps, more convenient. Let us proceed to divide the horizontal line. We have chosen the points A and C, and we wish to find the point E, so that A C and C E may represent equal lines. Draw O V″ to the vanishing point of the lines in this wall, draw AB parallel to it;

draw O C cutting A B in D; make D B equal to D A; and divide this line D B in exactly the manner that

Fig. 31.

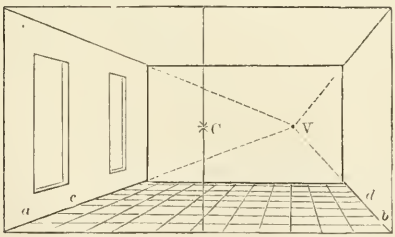


the original line is divided, and to the various divisions draw lines from O; where these produced cut A E are the pictures of these points on the drawing. The points *abcdef* are thus found in their true positions. The principle on which this construction is based is that previously referred to. The line from the eye to V is parallel to the line A E in the wall. These lines, from the extremities of A O, are turned round so as to coincide with the paper, retaining their parallelism.

If the main lines of a hall or interior are per-

pendicular to the plane of the picture, as is the case when a direct view is taken, the vanishing point of these lines will lie on the centre of the picture; and the original lines parallel to the plane of the picture, such as the transverse markings on the pavement and the lines on the wall confronting us, will be all parallel to the bottom margin of the picture. They will have no vanishing point. If the oblique view should be taken as that given in the sketch (fig. 32), the vanishing point being to one side of the centre, the transverse lines, being now *not* parallel to the plane of the picture, will have a vanishing point; and they must *not* be allowed to appear parallel to the bottom edge of the drawing-pad. Such an interior as that drawn

Fig. 32.



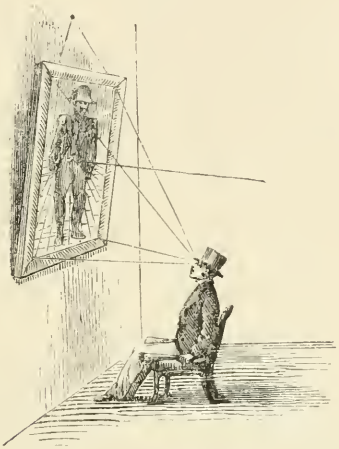
is wrong for the reasons stated. The lines *a b*, *c d*, &c. should not be parallel to the lower edge of the

frame. The mistake here shown is that most frequently seen in drawings.

It has been said that a person desiring to look at a picture should stand in reference to it as the artist stood in reference to the original. This is very desirable, though within certain limits not necessary. Almost the same projection falls from a picture upon the eye, no matter where situated. It will, of course, be larger when the picture is near, and smaller when remote, and will be slightly foreshortened when seen from one side; but, broadly speaking, a picture will give the same projection to a crowd of visitors looking at it, and the mental impression which will follow will be the same. Still the nearer one can pose himself on the direction of the original line of sight, and at the true distance, the better will be the effect. If a portrait is taken of a man standing on a floor, a portion of the floor is seen. If the figure should be raised upon a dais, less and less of the floor is seen as the platform on which it stands is elevated; and when the height of the eye, or horizontal line, is passed, none of it is visible. A portrait of a man taken in the first position, if hung up high upon a wall, will have an unnatural effect, which simply arises from the observer's eye not being anywhere near the

true point of sight. The figure will appear to be slipping off the floor, which will seem to stand at

Fig. 33.



an unnatural slope. Bending the picture forward will in a measure counteract this unpleasing effect, for it will tend to bring the line of sight in such a position that the observer can place his eye on it.

The figure shows what is here described. The observer, being much below the line of sight, sees the floor as though it were tilted up, and the figure as though it were slipping out of the frame. It follows, from what has been said, that pictures should be arranged in a gallery with some reference

to the 'distance of the picture' and to the 'line of sight.' The width of an ordinary landscape view taken upon a drawing-pad of about a foot or eighteen inches long would subtend at the eye an angle of about 90°, and the distance of the eye would be about a foot. The width of a man taken full size would subtend but a few degrees, and the distance of the eye would be many feet. We see at once how we violate the conditions referred to, in hanging small pictures at a distance on the top of a wall and hanging large ones near us at the bottom. The latter, by retreating from them, can no doubt be viewed from the proper distance; but the former, which should be held near the eye, so as to subtend an angle of 90° or more, must be viewed at a tenfold greater distance than should be the case. These considerations seem to be lost sight of in all galleries.

It has been remarked that where still water reflects an image, the reflection follows certain laws: care must be taken that the finished sketch shows no violation of such laws. The law of reflection is this: that any ray which speeds from an illuminated body, if it meet with a sheet of water or a piece of silvered glass, will be turned in its course, so that it will leave the surface after impinging

on it in a path similarly situated with regard to the surface to the one it travelled before reaching it. In the language of optics the angle of reflection will be equal to the angle of incidence; also the plane in which this incident and reflected ray will lie, will be perpendicular to the surface. So that, in the case of water, the surface of which is horizontal, the plane of reflection is vertical. From this it follows that the reflection of any object in still water will appear directly under the object itself. The reflection of the moon in the sketch

Fig. 34.

must be made to appear exactly under the real moon; but, more than this, its distance from the plane of the water must be made equal on the drawing to the height of the moon above it. O M must equal O M′.

If the water should be slightly ruffled with the wind, the moon, instead of being distinctly seen

in the water, will appear as a streak of light, broadening from the horizon towards the feet. This line of light is due to the ripples on the water, each of them bending one of the rays that fall on it in the direction of the eye. When the water was still, though the whole of it received rays from the moon, but one point was so situated as to send the rays to our eye; but when ruffled its surface is made up of little waves, each of which, instead of emitting from it one ray only, will emit a vertical fan of rays, one of which from each fan will reach the eye.

To each observer of the moon there will be a separate reflection, or line of sheen, so that no two persons standing in a boat or on the shore will see the same line of light on the water.

Whether the moon be in the centre of the picture or at one side, its reflection will be exactly under it; and if the water ripples, its image in each little wave will also be exactly under it. It follows that in all cases the line of sheen (which will join these points) must be made parallel with one of the side edges of the drawing-pad. It may be thought strange that this should be so, for it is obvious to each person that the line of reflection of the water will run to his feet, and he would be

disposed to represent it as in 1, fig. 35. But a little thought will show that it must be represented as 2, fig. 35.

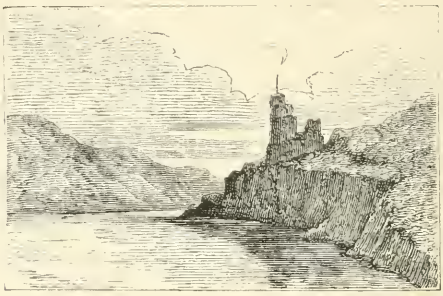
Fig. 35.

The plane containing the reflected rays is vertical, and the intersection of this plane with the plane of the picture must be vertical. That this is so can be easily demonstrated by tracing on a window-pane the line cast on the water by the moon. It will be found that, whether the moon is in the centre of the picture or at one side, the line of reflection in the water is at right angles to the window sill, or base of the picture.

An old ruin on the edge of a lake by moonlight is a favourite picture (fig. 36). The following considerations will assist one in such a sketch: The moon is here shown at but a very short distance above the castle. It will be remarked that in the water there is no reflection. The reason for this

will appear on looking at fig. 37, representing a section through the landscape. The moon being

Fig. 36.

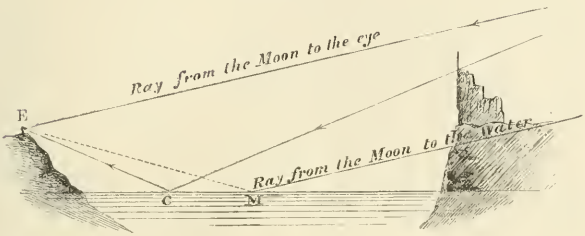


at an enormous distance, the ray from it to the eye is parallel to the ray from it to the water, which would be reflected into the eye; but this latter ray is impeded by the opaque ruin, and consequently cannot be reflected. It would be a mistake easily detected to reproduce the moon in both places under such circumstances.

A few remarks concerning colour will here be added. White light, or the light of the sun, is made up of all the colours of the rainbow (literally) mixed together. The rainbow simply exhibits the disintegration of a cone of rays at the apex of which is the sun, and on the axis of which is the observer. This can easily be as-

certained by observing the position of oneself as regards the rainbow. It will appear to be a

Fig. 37.



E, the eye of observer.
C, the point in the water where the top of the castle is seen reflected.
M, the point where the reflection of the moon would appear if the castle were removed.

portion of a circle swept round a line joining oneself and the sun. As with the reflection of the moon in the water, no two persons will see the rainbow in the same position; for each it is a circle, over the centre of which he stands himself. When the rain-drops which cause the rainbow have been dissipated, the light which was resolved into many colours becomes whole again by the intimate mixing of the colours. If when the colours were spread out—or 'dispersed,' blending from deep red to indigo—we were to take one tint away and allow the others to blend again without

it, it is evident that the fusion of the remainder would not be white. Whatever colour it happened to be, would be justly called the *complement* of the one taken away, for it is that which the withdrawn colour would want to make it white. As eightpence would be the complement of fourpence, the shilling being considered as the whole, or sevenpence the complement of fivepence, so would any colour be *complementary* to that which if mixed with it would form white. Experiments to prove that colours, if mixed in due proportion and of the proper tints, will form white cannot be well performed with ordinary paints; for these are impure, and it is extremely difficult to choose the correct tints. Nothing will prove this so well by demonstration as the polariscope, by which coloured *lights* can be made to blend; but the thing is obvious that if white light consists of the blending, say, of six colours, any one or more of these will together be complementary to the remainder. As we should expect so we find, that colours which are complementary present the greatest contrast. That which completely neutralises anything is obviously its greatest contrast. The yellow and purple of a pansie are complementary, and consequently the brilliance of

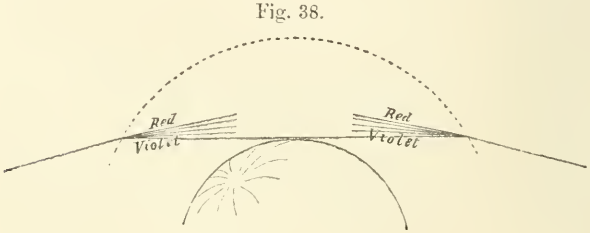
each is much enhanced by lying next its opposite. The pink of the rose is also nearly complementary to the bluish green of the leaves, and consequently is more striking to the eye than when held next yellow or orange flowers. Artists avail themselves of these contrasts to enhance effects, and avoid them to produce harmony. If a portrait were taken in a green chair, the face would not bear to be coloured highly; but if in a red chair, the face would bear a deeper red.

Very few remarks will be made on the subject of colour. Artists have written much about it, but the writer confesses that he has gathered but few ideas from their works. Mr. Ruskin has written six large volumes upon art, and yet appears to pique himself upon his ignorance of many simple points. It is strange if here, as in many other subjects, the philosopher or chemist should in a dry treatise, void of eloquence or rounded periods, be found to offer in a few simple words the explanation which has not been enclosed in the meshwork of fine writing of the art critic. Talking of clouds and the colour of the atmosphere, Mr. Ruskin observes: 'Is it the watery vapour or the air itself which is blue? Are neither blue, but only white, producing blue when seen over

dark spaces? If either blue or white, why, when crimson in their commanded dress, are the most distant clouds crimsonest? Clouds close to us may be blue, but far off golden—a strange result if air is blue. And again, if blue, why are the rays that come through large spaces of it red? And that Alp, or anything else that catches far-away light, why coloured red at dawn and sunset? No one knows, I believe.'

Very simple is the explanation of the colour of the air and the tint of 'that Alp at dawn and sunset.' Round drops of water disintegrate the

Fig. 38.



sun's light and produce a rainbow of many colours. A globe of air would do the same, and this earth in its outer covering resembles such a globe of air. When the rays from the sun fall obliquely on that portion of this envelope of air which forms our sky, they are disintegrated in exactly the same

way. The first colour in the morning will be that of the ray most bent—viz. violet-grey—and the last will be red. In the evening the first will be red and the last will be violet-grey. In the morning the mountain tops first catch those rays of the sun which are most bent or 'refracted,' and these are the violet; and the last caught are those least bent —viz. the red. In the evening the reverse is the case. The body of air through which the rays penetrate when the sun is on the horizon is considerably greater than when it has risen, and, as we should expect, its absorptive effect is increased. The blue rays, which are those ordinarily reflected, are now absorbed, and the remaining light is a soft orange tint.

In India after the rains, when the air is charged with moisture, the refraction is greater than in these latitudes, and the various colours of the rainbow are seen in the most gorgeous brilliancy on the clouds at sunset and sunrise. The green colour, which is seldom seen with us, is there most distinct and beautiful. Mr. Ruskin, referring to a coloured solution of nettles, thinks that 'perhaps some day, as the motion of the heavenly bodies by the help of an apple,' this question, 'by the help of a nettle, may be explained to mankind.'

It is very simply explained by the laws of refraction and absorption of light. As regards the colour of the air, this is due to its containing in it matter in a state of extremely minute division. This matter casts back upon the eye the tender blue rays falling on it. The stronger waves of the red and other lights break through the air, and not being reflected do not evidence themselves. The slighter the depth of air above one the darker the sky appears. On the top of high mountains or in balloons it is almost black. It is quite lawful to the artist—indeed, necessary to him—to avail himself of any artifice to produce on the mind of a person looking at his picture the same effect that was received by himself in looking at the original view. He must make the distance bluish and hazy. This gives to the eye, schooled by practice, the idea of distance. He must take especial care that the size of clouds and other things is reduced as they recede from the eye. In colour also they must be more and more faint. It is especially necessary that the artist should avoid scattered lights. It is this defect which mars the appearance of most attempts of the beginner, without his knowing why. In nature the lights are scattered, but a drawing is not nature. By artifice it is designed

to give the same mental impression; but, as is evident from the foregoing, the conditions are so extremely different in the two cases of looking at a scene in nature and looking at its picture, that any expedient is allowable which will increase the natural effect of the latter. It is desirable that there should be a focus of interest in each picture, generally in or near the centre, and the main lines in a drawing are advantageously arranged, so that they guide the eye to this point. As in the hall shown in the frontispiece the main lines run to a point, so it is expedient in a landscape that the main directions should lead to a centre.

A photographic landscape is seldom agreeable, and yet it resembles the reality, in light and shade, more closely than any picture taken by the eye and hand can be expected to do. The reason is that it errs in those respects just alluded to. Its lights are generally scattered. There is no grouping of the light and shade. There is also an absence of composition, or what may be called the tricks by which the eye may be assisted to a pleasing and natural effect. It is well in landscape painting that the masses of light and shade should be *balanced*. If the drawing should be very dark in one corner of the foreground, a dark

cloud may be conveniently introduced into the opposite corner in the sky; or if one corner should be light, the opposite one should be light also.

The following point is worthy of remark: The true colour of an object, which it would exhibit if taken in the hand and examined, or inspected from all points of view, is not always that which it appears to have when it is one of many objects seen together. This change of colour, due to the contrast to which the eye is subjected, is very slight, and might almost be discarded. Such tints not really owned by the objects looked at are called *subjective*. Any bright hue will tend to make the colour on which it abuts of the complementary tint; thus the shadows of green trees, upon grass would appear slightly tinged with red. But more important is the change of *shade* of objects produced by contrast. An object appears to become light or dark, according to the background on which it is projected. The amateurs will be materially assisted by bearing this in mind. A wooden paling which runs across a background of dark trees and light grass will change its depth of shade for each background. It will be quite a light colour when passing the trees, and quite dark while passing the grass,

though in reality its colour is unaltered. This fact can be easily observed by looking at the railings which enclose any ground containing trees and grass. It would be a triumph of skill to paint a white horse upon a white background, and the avoidance of such necessities, though one of the tricks of art, is really suggested by nature.

The amateur should recollect that water-colours show their colours by their transparency. The white light of the paper comes to the eye through a thin layer of pigment, which bars a certain portion of the light from passing. That portion of the whole ray which is allowed to pass carries with it its peculiar hue. The light from the window or the sky plunges into the paper and comes out again bereft of a certain portion. Why the different pigments act as they do is another matter which may be left to the consideration of the chemist or philosopher, and with which the artist need not concern himself. In oil-paints the white-lead which forms the base of each colour acts as the white paper with the water-colours, and throws back to the eye the white light of day, *deficient* of certain rays. It at once follows that the water-colours must be lightly spread, or the white light will not be able to pass through them,

in which case the paints will be opaque and will have only the dull colour which they exhibit in their cakes, which, as everyone knows, is not nearly so beautiful as their colours when 'rubbed up' upon a white palette. These considerations lead to the following suggestion: If bright greens should be required in a drawing, it is better that the colour should be procured as a green from the colourman than made by the mixing of yellow and blue. Properly speaking, the yellow and the blue, when mixed, should give no colour at all but brown or dirty grey, as the following considerations will show. The blue colour, when spread upon a piece of paper, allows the white light to pass through it bereft of all its rays except the blue. A layer of yellow spread upon the paper would check all the colours of the rainbow except the yellow; so that if both layers were spread on the same spot, the blue which escaped through the first would be stopped at the second. If the order of layers was changed, the yellow which escaped through the first coat could not get through the second; so that one would expect to see only a grey colour; but the fact is that yellow—say gamboge—allows some white light and some green and the whole of the yellow to pass through it, and blue—say cobalt

—allows some white light and some green and the whole of the blue to pass through; so that where the two layers are spread one over the other, or are mixed, the white light and the green find their way clear through *both*, and consequently the green is the colour which the eye perceives. The writer is aware that no reflections of this kind will lead to proficiency in drawing, but he believes that no workman is the worse for understanding the mechanics of his tools, and he thinks that the amateur artist may at least be interested, and perhaps benefited, by understanding the conditions and surroundings of his craft.

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